10/506753

DT09 Rec'd PCT/PTO 03 SEP 2004

IMPROVED TURBINE

Field of the Technology

The invention relates to mechanical engineering and in particular to hydraulic, pneumatic and steam turbines for driving electrical generators, compressors of refrigerating devices, heat pumps, etc.

Previous State of the Art

A method for obtaining mechanical energy in a turbine is known, which includes a supply of a working medium into channels of a rotor of the turbine and acceleration of the working medium during flowing out from the channels in one direction to provide a rotation of the rotor, the working medium from the channels of the rotor is supplied into a closed space formed by a casing around the rotor and it interacts with friction with the casing and flows out through the channels in the casing being accelerated in one direction. The flowing out from the passages of the rotor and the casing is performed in one direction. The rotor and the casing drive in rotation one shaft, on which they are fixedly mounted (U.S. patent no. 3,282,560, NCI 415-80 1965).

The known method has the disadvantage that it is not possible to obtain a mechanical energy for the turbine from its rotor, since the torque generated in the rotor during flowing out of the working medium from its channels, in accordance with the law of conservation of moment quantity of movement moment is compensated by an opposite moment generated during braking of the spent working medium of the rotor on the inner surface of the casing, and a useful moment is generated only during the flowing out of the working medium from the openings of the casing under the pressure which remains after expansion of the working medium in the channels of the rotor, which leads to great energy losses (~50%).

A method of obtaining a mechanical energy in a turbine is known, which includes supplying a working medium into the channel of the rotor of the turbine and acceleration of the working medium during flowing out from the channels in one direction along a circumference perpendicular to the radius of the rotor with providing of rotation of the rotor, the working medium from the channels of the rotor is supplied into a space formed by the casing around the rotor and it interacts with friction with the casing and flows out through the openings in the casing being accelerated in one direction with providing of its rotation. The casing of the rotor is formed as a radial blade turbine and takes

opposite to the rotor (patent of Switzerland no. 669428 IPC F01D 1/28, 1989, the closest analog).

The disadvantage of this known method is insufficiently high quantity of obtained mechanical energy because during the flowing out of the working medium through four channels of the rotor and its supply into a space formed by the casing in form of the blade turbine around the rotor and flowing out through the openings in the casing between the instant of the turbine, the working medium located between the blades in instant of contact with streams of channels of the rotor is expelled-"knocked out"-, being accelerated to the speed of the stream from the channels of the rotor, for which a part of energy of the stream is used.

During flowing out through the openings in the casing in form of a radial blade turbine, there are losses for acceleration of the working medium in radial blades from centrifugal forces.

In addition, there are losses for ventilation during circulation of the working medium between the blades due to flowing out through openings in the casing.

Also, from the rotating casing in form of a radial blade turbine, the working medium flows out with a speed which is significantly different from the speed of rotation of the casing, which leads to losses of energy.

A jet reaction turbine is also known, which has a working wheel formed as a tube with a closed end, connected coaxially with the shaft, arranged with a possibility of rotation, with at least one pair of pipe with open ends radially fixed on the tube at opposite sides, a casing arranged with the possibility of rotation and surrounding the wheel, a housing which surrounds the wheel and the casing and has openings for arrangement of the shaft, and nozzles for supplying and discharging of the working medium. At least one pair of pipes with open ends is fixed on the casing at the opposite sides. The casing and the working wheel are arranged on the same shaft (U.S. patent no. 3,282560, NCI 415-80, 1964).

The disadvantage of this known turbine is its fixed connection of the casing and the working wheel arranged on the single shaft, and to rotation of the working wheel and the casing in one direction, that provides obtaining of mechanical energy only from one casing, while pipes of the working wheel are only throttling the pressure of supply of the working medium by the elements of the turbine, which leads to useless losses of energy and low turbine efficiency.

A radial turbine with two shafts is known, which has a Segner wheel formed as a tube with a closed end connected coaxially with the shaft and arranged with the possibility of rotation, at least one pair of pipes fixed on the tube radially at opposite sides and having open ends which are bent in opposite sides from their axes, wherein the axes of the bent open ends of the pipes are perpendicular to a plane extending through the axes of the pair of pipes pipes and the axis of the tube, wherein in a wall of the pipe openings corresponding to the pipes are provided, a casing is connected coaxially with the shaft and arranged with the possibility of rotation and surrounding the Segner wheel, a housing surrounding the Segner wheel and the casing with openings for arranging the tube of the Segner wheel and shafts of the Segner wheel and the casing, and a nozzle for flowing out of a working medium. The casing is formed as a blade turbine (patent of Switzerland no. 669428, IPC: F01D 1/28,1989, the closest analog).

The disadvantage of this known turbine is that in the casing formed as a blade turbine the blades are fixed to the disc along its end, which increases a centrifugal load on the blades due to an additional moment and an assembly of fixing of the blades is incapable of bearing a high load, that requires a reduction of circumferential speeds of the blade turbine and decreases the efficiency of the blade turbine.

For passage between the blades, a stream of the working medium from the nozzles of the rotor must be directed to the blades at a certain angle which is determined by the shape of the blades and the shape of the stream from the nozzles. In the known turbine the stream of the working medium from the nozzles is supplied onto the blades under different angles, which on an average leads to increased angles acceptable to the turbines with a separate nozzle apparatus and to decrease of the efficiency.

The use of a hollow rotor (Segner wheel) leads to losses for friction due to generation in a hollow of the rotor a circulation of the working medium which is entrained due to viscosity on the walls and an opposite flow in a medium part of the hollow of the rotor (Segner wheel), or in other words the formation of a pair whirl. As a result the power taken from the rotor with the hollow is lost.

With a partial supply of a working medium to the casing (blade turbine) from four nozzles of the rotor (Segner wheel), which rotates in an opposite direction, the working medium located between the blades at a low pressure in a moment of contact with the streams from the nozzles of the rotor, is expelled-"knocked out", being accelerated to a speed of the stream supplied

from the nozzles of the rotor, for which a part of the energy of the stream is used.

In the casing (blade turbine) there are losses for acceleration of the working medium in radial blades from centrifugal forces. In addition, there are losses for ventilation due to circulation of the working medium between the blades during flowing out through the openings in the casing.

Also, from the rotating casing in form of a blade turbine, the working medium flows out with a speed which significantly differs from the speed of rotation of the casing, which leads to energy losses.

The known turbine has a complicated construction and a complicated technology for its manufacture due to the use of a blade turbine as a casing.

Disclosure of Invention

With a proposed method of obtaining mechanical energy in a turbine, an objective of increase of mechanical energy obtained in a turbine is achieved by increasing the efficiency due to maximum use of a kinetic energy

of the stream of the spent working medium, flowing out from the channels of the rotor of the turbine and providing a minimal absolute speed of stream during flowing out from the channels of the casing.

The objective of providing a method of obtaining a mechanical energy in the turbine is achieved in that in the method of obtaining a mechanical energy in the turbine including a supply of a working medium into channels of a rotor of the turbine and acceleration of the working medium during flowing out from the channels in one direction along a circumference perpendicular to the radius of the rotor with providing rotation of the rotor, the working medium from the channels of the rotor is supplied into a space formed by the casing around the rotor and interacts with friction with the casing and flowing out through openings in the casing being accelerated in one direction with providing of its rotation, wherein in accordance with the present invention a space formed by the casing is formed closed and over a radius of a circumference along the outlet openings of the channels of the rotor, and the working medium flowing out through the openings of the casing is accelerated along the circumference perpendicular to a radius of the casing in direction which is opposite to flowing out from the rotor.

The formation of the space formed by the casing closed and over the radius of the circumference along the outlet openings of the channels of the rotor and the acceleration of the working medium flowing out through the openings in the casing along the circumference perpendicular to the radius of the casing in a direction opposite to the flowing out from the rotor, makes possible to provide a rotation of the casing of the turbine due to a useful use of an excessive kinetic energy of the working stream issuing from the channels of the rotor of the turbine, and leads to an increase of a mechanical energy obtained in the turbine.

Moreover, flowing out through the openings of the casing of a working medium takes place with a speed which is close to a circumference speed of the casing in an opposite direction, so that the absolute speed of the stream of the working medium is equal to zero which reduces the losses of mechanical energy.

The load can be applied to the rotor and the casing so as to provide the same circumferential speeds of rotation of the outer diameter of the rotor and the inner diameter of the casing.

The application of the load to the rotor and the casing so as to provides same circumferential speeds of rotation of the outer diameter of the rotor and the inner diameter of the casing allows to obtain a maximum efficiency of the turbine.

The proposed turbine solves the problem of increasing of mechanical energy obtained in the turbine by increasing the efficiency due to minimal losses of energy during throwing out of a working medium from the casing, and also a simplification of the construction of the turbine.

The objective of providing the turbine is solved in the turbine in which has a Segner wheel formed as a tube with a closed end, fixed coaxially with a shaft arranged with a possibility of rotation, with at least one pair of pipes fixed radially on the tube at opposite sides and having a open ends bent to opposite sides from their axes, with the axes of the bent open ends of the pipes perpendicular to the plane extending through the axes of the pair of the pipes and the axis of the tube, with openings in a wall of the tube corresponding to the pipes with casing connected coaxially with the shaft and arranged with the possibility of rotation and surrounding the Segner wheel, with a housing surrounding the Segner wheel and the casing with openings for arranging the tube the Segner wheel and the shafts of the Segner wheel and the casing, and

with a nozzle for flowing out of the working medium, wherein in accordance with the present invention the casing is formed as a cylindrical drum, with a cylindrical collar of the drum adjoining the bent ends of the pipes of the Segner wheel with a gap, at least one pair of the pipes fixed radially on the cylinder collar of the drum at opposite sides and having open ends bent to opposite sides from their axes which are opposite to the sides of the pipes of the Segner wheel, wherein the axes of the bent open ends on the pipes of the drum are perpendicular to a plane extending through the axes of the pair of the pipes of the drum and the axis of the tube, with openings formed in a wall of the collar in correspondence with the pipes.

The formation of the casing as a cylindrical drum, the adjoining of the cylindrical collar of the drum to the bent ends of the pipes of the Segner wheel with a gap, the fixation of at least one pair of the pipes of the cylindrical collar of the drum radially from opposite sides and having open ends bent to opposite sides from their axes opposite to the sides of the pipes of the Segner wheel, with the axes of the bent open ends of the pipes of the drum perpendicular to the plane extending through the axes of the pair of the pipes of the drum and the axis of the pipe, with openings formed in the wall of the collar in correspondence with the pipes, allows the spent working medium flowing out from the Segner wheel to interact with the cylindrical collar of the drum arranged

very close at a distance of the gap from the bent ends of the pipes of the Segner wheel so as to drive it in rotation, and allows during its flowing out from the open ends of the pipes of the drum to enhance the rotation of the drum, and also allows to simplify the construction and technology of its manufacture due to replacement of the blade turbine.

Moreover, the flowing out from of the open ends of the cylindrical drum of the working medium takes place with a speed which is close to a circumferential speed of the cylindrical drum in an opposite direction, so that an absolute speed of the working medium stream is close to zero, which increases the efficiency of the turbine.

The use of one or more pairs of the pipes allows to drive the drum in rotation and obtain from it an additional mechanical energy.

Therefore, an additional mechanical energy is obtained from the rotation of the drum, which increases the efficiency of the turbine.

The pipes of the Segner wheel can be formed streamlined.

The formation of the pipes of the Segner wheel streamlined, or in other words with outer contours that during movement provides a lowest resistance of the counter stream of the working medium, for example in a cross-section in form of a drop-shaped profile, allows to reduce aerodynamic losses for friction during rotation of the Segner wheel in the drum filled with the working medium, which allows to increase mechanical energy obtained in the turbine. The streamlined shape of the pipes of the Segner wheel can be formed in a cross-section in form of a wing-shaped profile with a ratio $L/b \geq 5$,

wherein L is a chord of a wing,

b-is a maximum thickness of the wing.

The formation of the streamlined shape of the pipes of the Segner wheel in the cross-section in form of a wing-shaped profile with the ratio $L/b \geq 5$,

wherein L-is a chord of the wing,

b is a maximum thickness of the wing,

allows to obtain most optimal conditions for reduction of aerodynamic losses for friction during rotation of the Segner wheel in the drum filled with the working medium.

The pipes of the drum can be formed streamlined.

The formation of the pipes of the drum streamlined, or in other words having outer contours providing during movement the least resistance of the counter flow of working medium, for example in a cross-section in form of a drop-shaped profile, allows to reduce aerodynamic losses for friction during rotation of the drum in a housing filled with the working medium.

The streamlined shape of the pipes of the drum can be formed in a cross-section in the form of a wing-shaped profile with the ratio $L/b \geq 5$,

wherein L-is a chord of the wing,

b is a maximum thickness of the wing.

The formation of the streamlined shape of the pipes of the drum in a cross-section in form of a wing-shaped profile with the ratio $L/b \geq 5$,

wherein L-is a chord of the wing,

b is a maximum thickness of the ring.

allows to obtain the most optimal conditions with reduction of aerodynamic losses for friction during rotation of the drum in a housing filled with the working medium.

Brief Description of the Drawings

Figure 1 shows a general view of a turbine in a cross-section; Figure 2 is a view along A in Figure 1; Figure 3 is a longitudinal section of a pipe of a Segner wheel or a drum, formed in a section in form of a wing-shaped profile; Figure 4 is a section along A-A in Figure 3; Figure 5 is a section along B-B in Figure 3.

Best Variant of the Invention

A turbine has a Segner wheel formed as a tube 1 with a closed end, connected coaxially with a shaft 2, the tube 1 with the shaft 2 are arranged with the possibility of rotation on the bearings. At least one pair of pipes 3 is fixed on the tube 1 radially at opposite sides, with open ends 4 bent to opposite sides with axes of the bent open ends of the pipes 3 perpendicular to a plane extending through the axes of the pair of pipes 3 and the axis of the pipe 1, while openings 13 are formed in a wall of the pipe 1 in correspondence with the pipes 3. The open ends 4 can be formed as nozzles. A cylindrical drum 5 connected coaxially with a shaft 6 is arranged coaxially to the tube 1 with the possibility of rotation on bearings and surrounds the Segner wheel. A cylindrical collar 7 of the cylindrical drum 5 adjoins the bent open ends 4 of the pipes 3 of the Segner wheel with a gap. At least one pair of pipes 8 with open ends 9 bent to opposite sides from their axes opposite to the sides of the pipes 3 of the Segner wheel

are arranged on the cylindrical collar 7 of the cylindrical drum 5 radially at opposite sides. The axes of the bent open ends 5 of the pipes 8 of the cylindrical drum 5 are perpendicular to the plane extending through the axes of the pair of pipes 8 of the cylindrical drum 5 and the axis of the tube 1. Openings 10 are formed in a wall of the cylindrical collar 7 of the cylindrical drum 5 in correspondence with the pipes 8. There is a housing 11 which surrounds the Segner wheel and the cylindrical drum 5, with openings for arrangement of the tube 1 of the Segner wheel and the shafts 6 and 2 of the cylindrical drum 5 and the Segner wheel and with a nozzle 12 for flowing out of the working medium. The housing 11 is connected with an inlet pipe 14 for supplying of the working medium. The tube 1 of the Segner wheel has on its inlet part a plurality of grooves 15 so as to form together with the input pipe 14 labyrinth seals, providing minimal leaks of the working medium supplied into the turbine.

The pipes 3 of the Segner wheel can be formed streamlined, for example in a transverse cross-section in form of a drop-shaped profile.

The streamlined shape of the pipes 3 of the Segner wheel can be formed in a transverse cross-section in the form of a wing-shaped profile with a ratio $L/b \geq 5$,

wherein L-is a chord of the wing

b is a maximum thickness of the wing.

The pipes 8 fo the cylinder drum 5 can be form streamlined, for example in transverse cross-section in form of a drop-shaped profile.

The streamlinedshape of the pipes 8 of the cylinder drum 5 can be formed in a transverse cross-section in the form of wing-shaped profile with a ratio $L/b \geq 5$,

wherein L-is a chord of the wing,

B is a maximum thickness of the wing.

The selection of the least aerodynamic integral losses during rotation of the pipes 3 of the Segner wheel and the pipes 8 of the cylindrical drum 5 formed in a transverse cross-section in form of the wing-shaped profile, for example a symmetrical profile of Zhukovsky, is provided in accordance with the value of profile resistance $C_x=0.02$ in accordance with a method disclosed in the book G.I. Abramovich "Applied Gas Dynamics" published by "Nauka", publishing house of Physical-Mathematical Literature, M, 1969, p. 545, Fig. 10, 12. The symmetrical profile of Zhukovsky is shown in Figs. 3, 4, and 5.

The turbine operates in the following manner.

The working medium is supplied into the input pipe 14 and the tube 1 of the Segner wheel and further is supplied into the channels of each pair of the pipes 3. The working medium flows out with a high speed from opposite open ends 4 of the pipe 3 being accelerated in one direction along the circumference perpendicular to the radius of the Segner wheel with providing of its rotation due to generation of a moment of reactive forces.

The spent stream of the working medium is supplied from open ends formed of the pipes 3 with a high speed into a hollow of the closed space around the Segner wheel, created by the cylindrical drum 5 and interacts with friction with the wall of the cylindrical drum 5 so as to drive it in rotation. Then, the working medium is supplied into the pair of pipes 8 of the cylindrical drum 5 and flows out through the open ends 9 with the high speed being accelerated and driving in rotation the cylindrical drum 5 due to generation of a moment of reactive forces.

During the process of rotation of the cylindrical drum 5, the stream of the working medium flowing out from the open ends 4 is braked inside the cylindrical drum 5 by forces of friction to its circumferential speed so as to generate a moment of friction which rotates the cylindrical drum 5. Simultaneously, during rotation of the cylindrical drum inside it centrifugal forces

act on the working medium to generate centrifugal pressure, under the action of which issuance of the working medium from the open ends 9 of the cylindrical drum 5 takes place to generate an additional moment which is summed with the moment of friction.

From the rotating Segner wheel and cylindrical drum 5, the rotations are transmitted correspondingly to the shafts 2 and 6 and from them to a consumer.

Therefore, a useful utilization of energy of spent working medium in the Segner wheel and obtaining of an additional power is provided. Further, the working medium is supplied into the housing and flows out through the nozzle 12 for flowing out of the working medium.

The use of the pipe branches 3 and 8 correspondingly on the Segner wheel and the cylindrical drum 5 of streamlined shape allows to reduce aerodynamic losses during rotation of the pipes and to increase obtained mechanical energy in the turbine.

The method of obtaining mechanical energy in the turbine is performed in the following manner.

Working mediums is supplied into the channels of the rotor of the turbine. The working medium is accelerated, or in other words its speed is increased, during flowing out from the channels in one direction along the circumference of the radius of the rotor with providing a rotation of the rotor and obtaining mechanical energy. During this process, together with the rotor its shaft rotates as well, from which a useful energy is taken.

The working medium is supplied from the channels of the rotor into a closed space around the rotor and interacts with friction with the casing, which forms the closed space and is formed over a radius of circumference over the outlet openings of the channels of the rotor. The formation of the casing along the radius of the circumference along the output openings of the channels allows the rotation of the casing around the rotor, and the interaction with friction of the working medium with the casing leads to rotation of the casing simultaneously creating a centrifugal pressure inside the casing. The casing for example can be formed as a drum.

Then, the working medium flows out under the action of the centrifugal pressure through openings in the casing (there can be for example openings 10 in the cylindrical drum 5 and openings in the pipe 8), being accelerated in one direction along the circumference perpendicular to the radius

of the casing and in direction opposite to flowing out from the rotor, which provides a rotation of the casing and obtaining of mechanical energy. The flowing out with acceleration (increase of the speed) from the openings of the casing in one direction along the circumference perpendicular to the radius of the casing allows to drive the casing in a rotation, while braking of the working medium flowing out from the channels of the rotor into the casing allows to increase the effect of rotation due to forces of friction of the working medium against the casing and reactive forces. During this process, together with the casing its shaft rotates as well, from which additional useful energy is taken.

A load can be applied to the rotor and the casing so that it provides equal circumferential speeds of rotation of the outer diameter of the rotor and the inner diameter of the casing. This is performed by connecting of energy by a customer, for example of electrical generators to the shafts of the rotor and the casing and providing such modes of their operation, that the circumferential speeds of rotation of the outer diameter of the rotor and the inner diameter of the casing are equal. In this case it is possible to obtain a maximum efficiency of the turbine.

In accordance with the law of conservation moment of quantity of movement moment, the torque acting on the rotor M1 is equal to the summary

torque M2 acting on the casing: $M_1=M_2$. If the speed of flowing out of 1 Kg/s of working medium from the channels of the rotor is W_1 at a radius R, then

$$M_1 = M_2 = (W_1 - V_2) \cdot R,$$

wherein V1-is a circumferential speed of the rotor.

The power developed by the rotor at angular speed

$$\omega 1 = V_1/R$$

$$N_1 (W_1 - V_1) \cdot R \cdot V_1/R = (W_1 - V_1) \cdot V_1$$

Correspondingly with the same torque M1=M2 the power developed by the casing will be at

$\omega 2 = V2/R$, where V2-is a circumferential speed of rotation of the casing

$$N_2 = (W_1 - V_1) \cdot R \cdot V_2/R + (W_1 - V_1) \cdot V_2$$

Correspondingly, with equal circumferential speeds $V_1=V_2$ and absence of aerodynamic and other losses, the provision of the rotating casing allows to additionally obtain the same power as the power of the rotor, or in other words to double the summary power of the system rotor-casing and to obtain a maximum theoretical efficiency of the turbine.

At $V_1=V_2=V$ the efficiency of the turbine is:

$$\eta=(N_1+N_2)/W_1^2/2=4\ (V/W_1-V_2/W_1^2).$$

With ratio V/W1=0.25

$$\eta=4(0.25-(0.25)^2)=0.75.$$

As the working medium in the turbine, it is possible to use liquid, gas and vapor.

Example of Use of the Method

The turbine operates with water steam. A rotor of the type of the Segner wheel with two channels is used. Water steam is supplied into two channels of the rotor and a stream of the water stream is accelerated during flowing out from the channels in one direction along the circumference perpendicular to a radius of the rotor to the speed 790 m/s. A rotor with the radius R=0.48 m and a rotary speed m=5000 rev/min is used. The circumferential speed of the rotor is 251 m/s. The rotor rotates and mechanical energy is taken from its shaft.

Then the water steam from the channels of the rotor is supplied into a closed space around the rotor and interacts with friction with the casing which forms the closed space and is formed over the radius of circumference along the outlet openings of the channels of the rotor. Through the openings of the casing the water steam flows out being accelerated to the speed 251 m/s in one direction, a long the circumference perpendicular to a radius of a casing and in an opposite direction to flowing out from the rotor with providing rotation of the casing. The radius of the casing insignificantly exceeds the radius of the rotor and is 0.4805m, and the rotary speed of the casing is n=4990 rev/min. The rotary speed of the casing is 251 m/s. The casing rotates and from its shaft an additional mechanical energy is taken.

To the shafts of the rotor and the casing, a load is applied by a arranging of separate electrical generators on both shafts, and such modes of operation of the electrical generates are provided that the circumferential speeds of rotation of the outer diameter of the rotor and the inner diameter of the casing become equal-251 m/s. In this case, from the turbine a maximum mechanical energy is taken with a theoretical efficiency η=0.86.

The proposed method of obtaining mechanical energy in a turbine is confirmed experimentally, and the turbine realizing this method was successively tested.

Industrial Applicability

Most successively the present can be used as a hydraulic, pneumatic and steam turbine for driving of electrical generators, compressors of refrigerating devices and heat pumps.